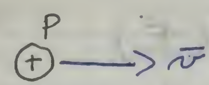
Tarea #3

21... 25, 29, 31, 43, 45

P 718
21.27)



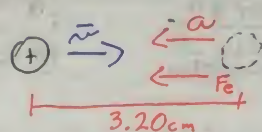
$v = 4.50\times10^{6}\ m/s$

$m_p = 1.673\times10^{-27}\ Kg$

$q_p = 1.6\times10^{-19}\ C$

a) $v_f = 0$

$d = 3.20\ cm$



$$v_f^2 + v_0^2 = 2a\Delta x \Rightarrow a = \frac{v_f^2 + v_0^2}{2\Delta x}$$

$$a = \frac{0 + (4.50)^2\times10^{+6}}{2(0.0320)} = -3.16\times10^{14} \Rightarrow -3.16\times10^{14}\ m/s^2\ (\hat{\imath})$$

$$F = ma = (1.673\times10^{-27})(-3.16\times10^{14}) = -5.29\times10^{-13}\ N(\hat{\imath})$$

$$E = \frac{F}{q} = \frac{-5.29\times10^{-13}\ N(\hat{\imath})}{1.6\times10^{-19}\ C} = -3.31\times10^{6}\ \frac{N}{C}\ (\hat{\imath})$$

b) $\Delta x = v_0\Delta t + \frac{1}{2}a\Delta t \quad | \quad a = \frac{\Delta v}{\Delta t}$

$\left(\frac{v+v_0}{2}\right)\Delta t = \Delta x$ → Sólo para aceleración ctc.

$$\Delta t = \frac{2\Delta x}{v_0} = \frac{2(0.0320)}{4.50\times10^{6}} = 1.42\times10^{-8}\ s$$

c) $$F = ma = (\overset{m_e}{9.11\times10^{-31}})(-3.16\times10^{14}) = -2.88\times10^{-16}\ N(\hat{\imath})$$

$$E = \frac{F}{q} = \frac{-2.88\times10^{-16}}{-1.6\times10^{-19}} = 1800\ \frac{N}{C}\ (\hat{\imath})$$

$$\vec{F} = q\vec{E}$$

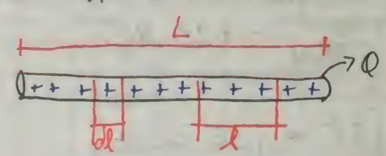
si q (+) $\vec{F}$ misma dirección $\vec{E}$

si q (−) $\vec{F}$ dirección opuesta $\vec{E}$

21/7/14

Cargas Uniformemente Distribuidas

1) Densidad lineal de carga λ lamda

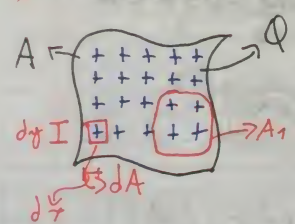


$$\lambda = \frac{\text{carga total}}{\text{Long. total}}$$

$$\lambda = \frac{Q}{L}$$

$$dq = \lambda\, dl \qquad q = \lambda\, l$$

2) Densidad superficial de carga σ sigma

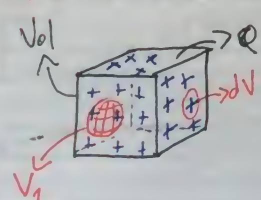


$$\sigma = \frac{Q}{A}$$

$$q = \sigma A_1$$

$$dq = \sigma\, d_x\, d_y$$

3) Densidad Volumétrica de carga ρ ro



$$\rho = \frac{Q}{Vol}$$

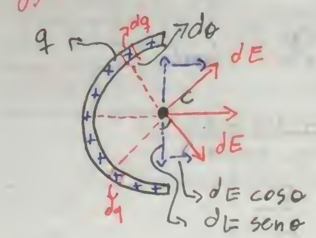
$$q = \rho V_1$$

$$dq = \rho\, dV$$

$$dq = \rho\, dx\, dy\, dz$$

$s = r\theta$ $\qquad$ $l = \pi r \rightarrow$ media circ.

ξj) Calcule el campo eléctrico en "C"



$l_{varilla} = 30\,cm$

$q_{dist} = +20\,\mu C$

$E = \int d\vec{E} = \int dE\cos\theta$

$E = \int K \frac{dq}{d^2}\cos\theta = \frac{K}{d^2}\int \lambda \overset{\text{por ser arco}}{ds} \cos\theta$ $\rightarrow$ por ser 1/4 circ

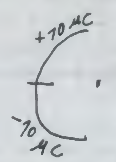
$E = \frac{K}{d^2}\lambda \int r\, \overset{\text{por ser dif de ángulo}}{d\theta} \cos\theta = \frac{K}{d^2} 2\int_0^{\pi/2} \cos\theta\, d\theta$

$E = \frac{2K\lambda}{r} \operatorname{sen}\theta \Big]_0^{\pi/2} = \frac{2K\frac{q}{\cancel{l}}}{\frac{\cancel{l}}{\pi}} \cancel{\operatorname{sen}\theta}^{1} \Big]_0^{\pi/2}$

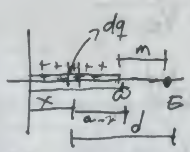
$E = \frac{2K\pi q}{l^2} = \frac{2 * (9\times10^9)(\pi)(20\times10^{-6})}{(0.30)^2}$

$E = 1.26 \times 10^{-7} \frac{N}{C} (\hat{\imath})$

Tarea #4



21, 47, 61, 73
71



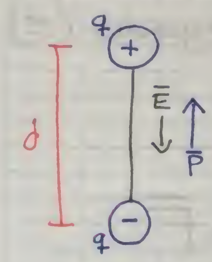
$\lambda = \frac{q}{a}$

$dE \quad K\frac{dq}{d^2} \Rightarrow E = \int dE$

$E = K\int_0^a \frac{\lambda\, dx}{(a+m-x)^2}$

23/7/74

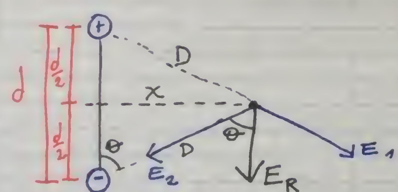
Dipolo Eléctrico



Momento dipolar

$\bar{p} = q\,d$ Hacia la carga positiva

Campo eléctrico debido a un dipolo



$$E_R = 2\,\overset{\to\ \text{ó}\ E_2}{E_1}\cos\theta$$

$$E_R = 2\,K\frac{q}{r^2}\cos\theta$$

$$E_R = 2\,K\left(\frac{q}{D^2}\right)(\cos\theta)$$

$$D = \sqrt{\left(\frac{d}{2}\right)^2 + x^2}$$

$$E = \cancel{2}\,K\left(\frac{q}{\left(\frac{d}{2}\right)^2 + x^2}\right)\left(\frac{\frac{d}{\cancel{2}}}{\sqrt{\left(\frac{d}{2}\right)^2 + x^2}}\right) = K\frac{q\,d}{\left(\left(\frac{d}{2}\right)^2 + x^2\right)^{3/2}}$$

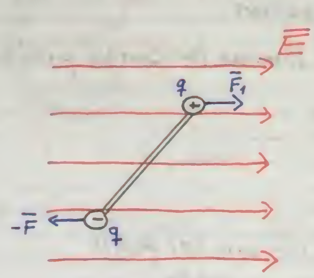
$$\boxed{E = K\frac{p}{\left[\left(\frac{d}{2}\right)^2 + x^2\right]^{3/2}}}$$ $\to \bar{E}$ en direccion $-\bar{p}$

Para $x >> d$ $$E = K\frac{p}{x^3}$$

Tarea 5: 21... 57, 59, 69, 75

Un dipolo dentro de un campo eléctrico constante:

- Lo produce una o mas placas cargadas ($\bar{E}$)



$$\bar{F} = q\bar{E}$$

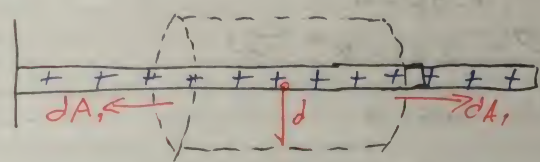
Torque:

$$\bar{\tau} = \bar{r} \times \bar{F}$$

1/8/14

Aplicaciones de la Ley de Gauss

22.18



$d = 0.100\ m$

$E = 84\ N/C$

$q = ?$

$l = 20\ cm$

$$\oint E \cdot dA = \frac{q_{NE}}{\varepsilon_0}$$

$$\int E\,dA \cos 0^\circ = \frac{\lambda L}{\varepsilon_0} \Rightarrow E \int dA = \frac{\lambda L}{\varepsilon_0}$$

$$E = \frac{\lambda}{\varepsilon_0 (2\pi d)} \Rightarrow \lambda = E\, 2\pi \varepsilon_0 d$$

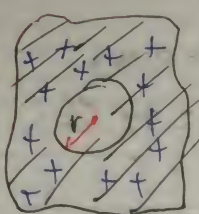
$$\lambda = \frac{q}{l} \Rightarrow q = \lambda l \Rightarrow q = E\, 2\pi \varepsilon_0 d l$$

$$q = 840 * 2\pi (8.85 \times 10^{-12})(0.400)(0.02)$$

$$q = 3.74 \times 10^{-10}\ C$$

22.. 15, 17, 19, $\underbrace{1, 2, 3, 5}_{\text{preg}}$

22.22)



$q = -200\,\mu C$

$r = 6.50\,cm$

$\rho = 7.35\times10^{-4}\ C/m^3$

$d = 9.50\,cm$

$$\oint E\cdot dA = \frac{q_{NE}}{\varepsilon_0} \Rightarrow \oint E\,dA\cos 0^\circ = \frac{q_{NE}}{\varepsilon_0}$$

$$E\int dA = \frac{q_{NE}}{\varepsilon_0} \Rightarrow E(4\pi d^2) = \frac{q_{NE}}{\varepsilon_0}$$

$$q_{NE} = -2.00\times10^{-6} + \rho\,vol$$

$$q_{NE} = -2.00\times10^{-6} + \rho\left(\frac{4}{3}\pi(d^3 - r^3)\right)$$

$$q_{NE} = -2.00\times10^{-6} + 7.25\times10^{-4}\left(\frac{4}{3}\pi(0.0095^3 - 0.0065^3)\right)$$

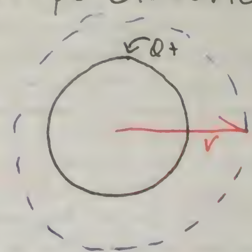
$$q_{NE} = -0.206\,\mu C$$

$$E(4\pi d^2) = \frac{q_{NE}}{\varepsilon_0} \Rightarrow E = \frac{1}{4\pi\varepsilon_0}\ \frac{q_{NE}}{d^2}$$

$$E = 9\times10^9 \times \frac{0.206\times10^{-6}}{(0.0950)} = 2.05\times10^5\ N/C$$

4/7/14

Campo Eléctrico debido a una esfera cargada



$E = ?$

$$\oint E\, dA = \frac{q_{NE}}{\varepsilon_0}$$

$$\oint E\, dA \cos 0° = \frac{Q}{\varepsilon_0}$$

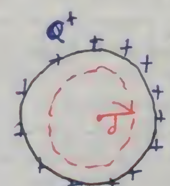
Afuera: no importa si es o no es conductora

$$E \oint dA = \frac{q}{\varepsilon_0} \Rightarrow EA = \frac{Q}{\varepsilon_0} \Rightarrow E\, 4\pi r^2 = \frac{Q}{\varepsilon_0}$$

$$E = \frac{1}{4\pi\varepsilon_0} \frac{Q}{r^2} \Rightarrow E = K\frac{Q}{r^2}$$

Dentro de la esfera

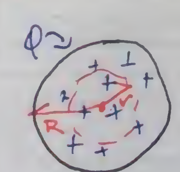
1) Esfera Conductora



$$\oint E dA = \frac{q_{NE}}{\varepsilon_0} \Rightarrow \oint E dA \cos 0° = \frac{0}{\varepsilon_0}$$

$$E \oint dA = 0 \Rightarrow E = 0$$

2) No conductora



$$\rho = \frac{Q}{Vol} \Rightarrow \rho = \frac{Q}{\frac{4}{3}\pi R^3}$$

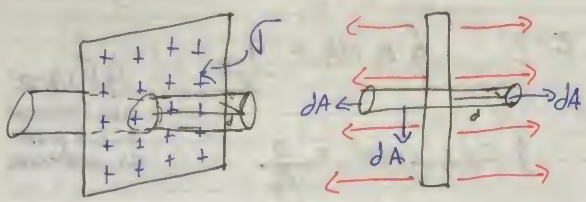
$$\oint E dA = \frac{q_{NE}}{\varepsilon_0} \Rightarrow \oint E\, dA = \frac{q_{NE}}{\varepsilon_0}$$

$$E \oint dA = \frac{\rho\, Vol.}{\varepsilon_0} \Rightarrow E\, 4\pi r^2 = \frac{\frac{Q}{\frac{4}{3}\pi R^3} \times \frac{4}{3}\pi r^3}{\varepsilon_0}$$

$$E = \frac{1}{4\pi\varepsilon_0} \times \frac{Q r}{R^3}$$

22... 21, 23, 25, 27, 47

Campo eléctrico debido a una placa no conductora

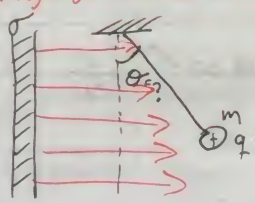


$$\oint E\cdot dA = \frac{q_{NE}}{\varepsilon_0} \Rightarrow \int E\, dA_1 + \int E\, dA_2 = \frac{q_{NE}}{\varepsilon_0}$$

$$A_1 E + A_2 E = \frac{\sigma A}{\varepsilon_0} \Rightarrow AE + AE = \frac{\sigma A}{\varepsilon_0}$$

$$2E = \frac{\sigma}{\varepsilon_0} \Rightarrow E = \frac{\sigma}{2\varepsilon_0}$$

22.43) Figura en libro mala

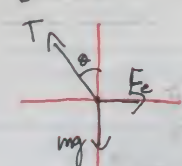


$\sigma = 2.50\times10^{-9}\ \frac{C}{N\cdot m^2}$

$q = 5.00\times10^{-8}\ C$

$m = 4.00\times10^{-6}\ kg$

D.C.L.



$$\Sigma F_y = 0 \Rightarrow T_y = mg$$

$$T\cos\theta = mg \Rightarrow T = \frac{mg}{\cos\theta}$$

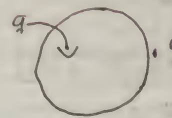
$$\Sigma F_x = 0 \Rightarrow F_e = T_x$$

$$Eq = T\,\mathrm{sen}\,\theta \Rightarrow \frac{\sigma}{2\varepsilon_0} q = \frac{mg}{\cos\theta}\,\mathrm{sen}\,\theta$$

$$\frac{\sigma q}{2\varepsilon_0 mg} = \tan\theta \Rightarrow \tan\theta = \frac{(2.50\times10^{-9})(5\times10^{-8})}{2(8.85\times10^{-12})(4\times10^{-6})(9.8)} \Rightarrow \theta = 10.21°$$

22..., 33, 35, 45, 49, 51 / 11, 12, 13
Preg

22.27)

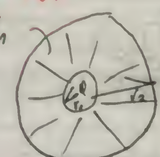


$w = \int \cancel{F\,dx}$

$\int_r^{\infty} F\,dx = \int_r^{\infty} E q\,dx = \int_r^{\infty} \frac{k\,q_1 q_2}{x^2} = k\,q_1 q_2 \int_r^{\infty} \frac{dx}{x^2}$

22.28)

q_1



a) sup interior del conductor

b) sup ext. del conductor

$r_1 = 5$ cm

$r_2 = 10$ cm

$E = ?$ $d_1 = 3$ cm

$E?$ $d_2 = 8$ cm

$E?$ $d_3 = 15$ cm

$q_1 = 5\,\mu C$

$q_2 = -6\,\mu C$

$\oint E\,dA = \frac{q_{NE}}{\varepsilon_0}$

$\oint E\,dA \cos 180 = \frac{q_2}{\varepsilon_0} \Rightarrow E \int dA = \frac{q_2}{\varepsilon_0}$

$E(4\pi d_1^2) = \frac{q_2}{\varepsilon_0} \Rightarrow E = \frac{1}{4\pi\varepsilon_0} \frac{q_2}{d_2^2}$

$E = (9\times10^9)\frac{(6\times10^{9})}{(0.03)^2} = 60{,}000$ N/C

$d = 8$ cm

$\oint E \cdot dA = \frac{q_{NE}}{\varepsilon_0} \Rightarrow \oint E\,A \cos 90 = \frac{0}{\varepsilon_0} \Rightarrow E = 0$

$d = 15$ cm

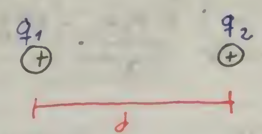
$\oint E\,A \cos 180 = \frac{q_1 + q_2}{\varepsilon_0} \Rightarrow \oint E\,dA = \frac{1\times10^{-9}}{\varepsilon_0}$

$E = 9\times10^9 \times \frac{1\times10^{-9}}{(0.15)^2} = 400$ N/C

Si sólo hay una carga no hay trabajo

8/8/14

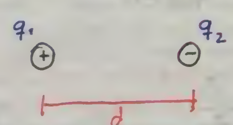
Energía Potencial Eléctrica



$$U = W = \int dw = \int \bar{F}\cdot d\bar{x}$$

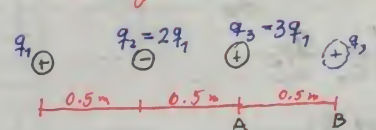
$$= \int_\infty^d F\,dx\cos 0^\circ = \int K\frac{q_1q_2}{x^2}\,dx = Kq_1q_2\int_\infty^d \frac{dx}{x^2}$$

$$\boxed{U = K\frac{q_1q_2}{d}}$$



Trabajo negativo

W para mover q_3 de A a B



$q_1 = 12\,\mu C$

$$U_0 = K\frac{q_1q_2}{{}_1d_2} + K\frac{q_3q_1}{d_{13}} + K\frac{q_2q_3}{{}_2d_3}$$

$$U_0 = K\left[\left(-\frac{2q_1^2}{0.50}\right) + \frac{3q_1^2}{1.00} - \frac{6q_1^2}{0.50}\right] = (9\times10^9)\left[(12\times10^{-6})^2\left(\frac{-2}{0.5}+\frac{3}{1}-\frac{6}{0.5}\right)\right]$$

$$U_0 = -16.85\ J$$

P1 24 Agosto Resumen cap 23

$$\overset{\text{en B}}{U_F} = K\left(\frac{-2q_1^2}{0.5} + \frac{3q_1^2}{1.50} - \frac{6q_1^2}{1}\right)$$

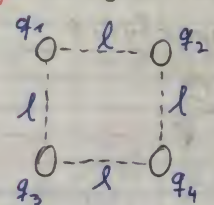
$$U_F = 9\times10^9 \times (12\times10^{-6})^2 \left[-\frac{2}{0.5} + \frac{3}{1.5} - \frac{6}{1}\right]$$

$$U_F = -10.37\ J$$

$$W = \Delta U = U_F - U_0 = -10.37 - (-16.85)$$

$$W = 6.48\ J$$

Ej) Energía en sistema



$$U = K\frac{q_1q_2}{l} + K\frac{q_1q_3}{l} + \frac{Kq_2q_3}{\sqrt{2}\,l} + \frac{Kq_1q_4}{\sqrt{2}\,l} + \frac{Kq_2q_4}{l} + K\frac{q_3q_4}{l}$$

$$F = K\frac{q_1q_2}{d^2} \qquad E = \frac{F}{q_0} \qquad \text{Vectores} \quad E = K\frac{q}{d^2}$$

$$U = K\frac{q_1q_2}{d} \qquad V = \frac{U}{q_0} \qquad \text{Escalares} \quad V = K\frac{q}{d}$$

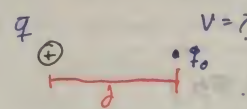
Los é buscan regiones de alto potencial

Campo E dentro $O_{cond} = \varnothing$

11/8/14

Potencial Eléctrico (V)

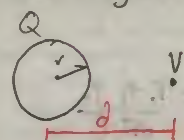
$$V = \frac{U}{q_0} = \frac{[J]}{[C]} = \text{Volt}$$



$$V = \frac{U}{q_0} \Rightarrow V = \frac{\frac{K q q_0}{d}}{q_0}$$

$$\boxed{V = K \frac{q}{d}}$$

Esfera Cargada:



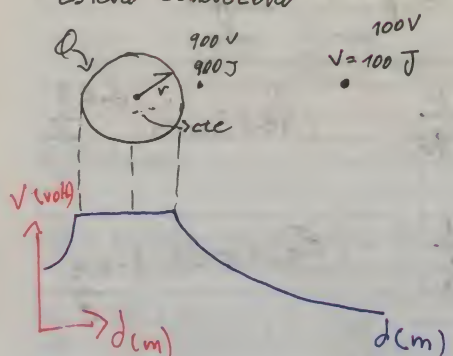
V = ?

$$V = K \frac{q}{d}$$

En la superficie

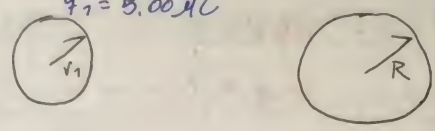
$$V = K \frac{Q}{r}$$

Esfera Conductora



23... 1, 3, 5, 11, 15

$q_1 = 5.00\,\mu C$ $\qquad$ $q_2 = -10.0\,\mu C$



$r = 20\,cm$ $\qquad$ $V_1 = V_2$

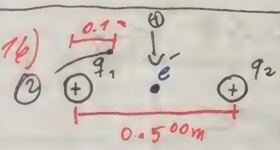
$R = 30\,cm$ $\qquad$ $\cancel{K}\dfrac{q_1}{r} = \cancel{K}\dfrac{q_2}{r} \Rightarrow Q_1 = \dfrac{r}{R}Q_2$

$Q_1 + Q_2 = -5\,\mu C$ $\qquad$ $Q_1 = \dfrac{20}{30}Q_2 \Rightarrow Q_1 = \dfrac{2}{3}Q_2$

$\dfrac{2}{3}Q_2 + Q_2 = -5\,\mu C \Rightarrow Q_2 = \dfrac{3}{5}(5\,\mu C)$

$Q_2 = -3\,\mu C \qquad Q_1 = -2\,\mu C$

23.1(6)



$q_1 = 3.00\,nC$ $\qquad$ $V = \dfrac{U}{q}$

$q_2 = 2.00\,nC$ $\qquad$ $\Delta V = \dfrac{\Delta U}{q}$

$V_1 = K\dfrac{q_1}{d_1} + K\dfrac{q_2}{d_2}$ $\qquad$ $q\Delta V = \Delta U$

$V_1 = (9\times10^9)\left(\dfrac{3\times10^{-9}}{0.25}\right) + (9\times10^9)\left(\dfrac{2\times10^{-9}}{0.25}\right) = 180\,V$

$V_2 = K\dfrac{q_1}{d_1'} + K\dfrac{q_2}{d_2'}$

$V_2 = (9\times10^9)\left(\dfrac{3\times10^{-9}}{0.1}\right) + (9\times10^9)\left(\dfrac{2\times10^{-9}}{0.40}\right) = 315\,V$

$\Delta V q = \Delta U \Rightarrow (V_2 - V_1)q = K_f - \cancel{K_0}^{\,0} \Rightarrow \dfrac{1}{2}mv_2^2 = (315-180)(1.6\times10^{-19})$

cambio de energia

$v_2 = \sqrt{\dfrac{2(315-180)(1.6\times10^{-19})}{9.11\times10^{-31}}} = 6.89\times10^6\ m/s$

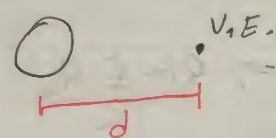
23.24)

$V = 4.98V$

$E = 12.0 \frac{V}{m} = 12.0 \frac{N}{C}$

a) $d = ?$

b) $q = ?$



$V = K\frac{q}{d} = 4.98$

$E = K\frac{q}{d^2} = K\frac{q}{d} * \frac{1}{d} = 12.0$

$4.98 * \frac{1}{d} = 12 \Rightarrow d = \frac{4.98}{12} = 0.415\,m$ //

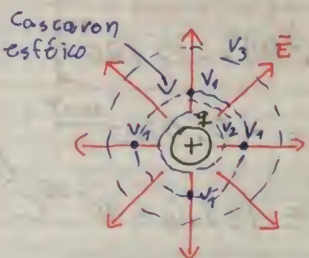
$E = \frac{V}{d} \Rightarrow V = Ed$

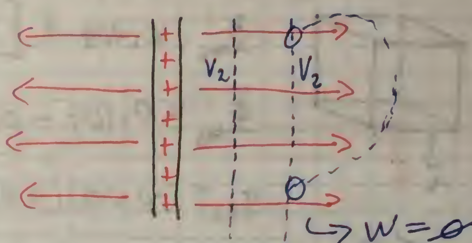
$q = \frac{Vd}{K} = \frac{4.98 \times 0.415}{9 \times 10^9} = 2.30 \times 10^{-10} C$ //

$q = \frac{Ed^2}{K} = \frac{12(0.415)^2}{9 \times 10^9} = 2.30 \times 10^{-10} C$

Lineas equipotenciales siempre son perpendiculares a las lineas de campo 18/8/14

Lineas Equipotenciales





P(6, T11)

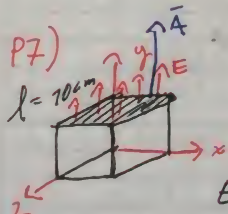
$$E_s = -\frac{dV}{ds} \Rightarrow E_x = -\frac{dV}{dx} \text{ ó } E_y = -\frac{dV}{dy}$$

$$V = 8y^2 - 12y + 25 \quad \text{en } (2,3,4)$$

$$E_y = -16y + 12$$

$$E_{(3)} = (-16(3) + 12)\bar{y} = -36 \frac{N}{C} \hat{j} \quad (c)$$

P7)



$$\Phi = E \cdot A$$

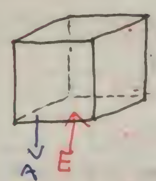
$$\Phi_{(0.10)} = E \cdot A \cos 0°$$

$$E_{(0.10)} = -16(0.10) + 12 = 10.4 \, N/C$$

$$\Phi = (10.4)(0.10)^2(1) = 0.104 \frac{Nm^2}{C} \quad (a)$$

Tarea T11

P8) $\oint \vec{E}\cdot d\vec{A} = \frac{q_{NE}}{\varepsilon_0} \Rightarrow q_{NE} = \Phi_{Tot}\,\varepsilon_0$

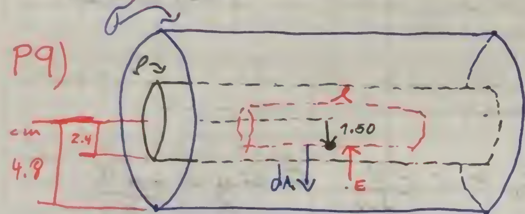


$$\Phi_{tot} = 0.104 + \left[\overset{E}{12} * (0.\overset{A}{100})^2 * \cos 180\right]$$

$$\Phi_{tot} = 0.104 - 0.120 = -0.016\ \frac{Nm^2}{C}$$

$$q_{NE} = (-0.016)(8.85\times10^{-12}) = 141.6\times10^{-15}\ C \quad (d)$$

P9)



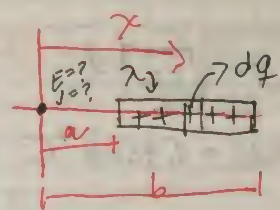
$\rho = -1.50\times10^{-5}\ C/m^3$

$\sigma = +3.50\times10^{-6}\ C/m^2$

$$\oint \vec{E}\, d\bar{A} = \frac{q_{NE}}{\varepsilon_0} \Rightarrow E\int dA_1 = \frac{\rho\, Vol_1}{\varepsilon_0}$$

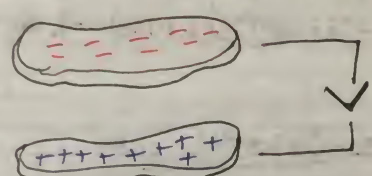
$$E\,(2\cancel{\pi}\cancel{d}\cancel{l}) = \frac{\rho\cancel{\pi} d^{\cancel{2}}\cancel{l}}{\varepsilon_0} \Rightarrow E = \frac{\rho d}{2\varepsilon_0}$$

$$E = \frac{1.50\times10^{-5} \times 0.0150}{2\,(8.85\times10^{-12})} = 12{,}712\ \frac{N}{C}$$



$$E = K\int \frac{dq}{r^2} = K\int_a^b \frac{\lambda}{x^2}\,dx = K\lambda\int_a^b \frac{dx}{x^2}$$

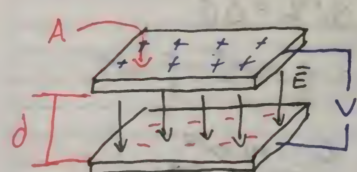
Capacitancia (C)



$$C = \frac{q}{V}$$

$$[C] = \frac{[C]}{[V]} = \text{Farad } [F]$$

Capacitores de Placas Planas Paralelas



$$C = \frac{q}{V} \Rightarrow C = \frac{q}{Ed} \Rightarrow C = \frac{q}{\frac{\sigma}{\varepsilon_0} d}$$

$$C = \frac{\varepsilon_0 \; q}{\frac{q}{A}\; d} \Rightarrow \boxed{C = \varepsilon_0 \frac{A}{d}}$$

HP1

4)

$F_c = k\frac{q^2}{d^2} \Rightarrow q = \sqrt{\frac{F_c}{k}}\, d$

$q = \sqrt{\frac{4.57\times10^{-21}}{9\times10^{9}}}(0.2) = 1.42\times10^{-16}\,C$

$\#e^- = \frac{1.42\times10^{-16}}{1.6\times10^{-19}} = 890.73 \approx \underline{891}_{//}$

5) $v_0 = 4.50\times10^{6}$ ~~t~~ m/s

$\Delta x = 3.20\ cm$

$v_f = 0$

$\cancel{v^2}^{\,0} - v_0^2 = 2a\,\Delta x$

$a = -(4.5\times10^{6})^2/2(0.0320) = -3.16\times10^{14}\ m/s^2$

$F = ma \Rightarrow qE = ma \Rightarrow E = \frac{ma}{q} = \frac{(1.67\times10^{-27})(3.16\times10^{14})}{1.6\times10^{-19}}$

$E = 3.3\times10^{6}\ N/C$

6) $\left(\frac{v_0 + \cancel{v_F}^{\,0}}{2}\right)\Delta t = \Delta x$

$\frac{v_0}{2}\Delta t = \Delta x \Rightarrow \Delta t = \frac{2\Delta x}{v_0}$

$t = 14.2\times10^{-9}\,s$

$V = \frac{U}{q} \Rightarrow \Delta V q = \Delta U$

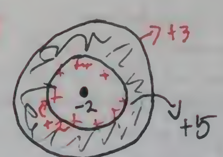
$E d q = \frac{1}{2}m\cancel{v_f^2} - \frac{1}{2}m v_0^2$

$E = \frac{m v_0^2}{2qd}$

11) $\Phi \Rightarrow q_{NE}$

↳ q permanece igual $\therefore\ \Phi$ igual

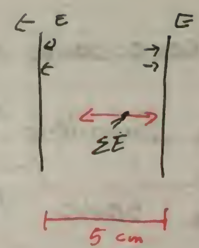
15)



$U = -\overline{P} \cdot E$ ← En dipolo

16) $\sigma_A = -9.50 \, \mu C/m^2$

$\sigma_B = -11.60 \, \mu C/m^2$



$E = \dfrac{\sigma}{\varepsilon_0}$ $\qquad$ $E = \dfrac{\sigma}{2\varepsilon_0}$

$E_1 = 1.07 \times 10^6$ $\qquad$ $E_1 = 5.37 \times 10^5$

$E_2 = \underline{1.31 \times 10^6}$ $\qquad$ $E_2 = \underline{6.55 \times 10^5}$

$2.[illegible] \times 10^6 (2)$ $\qquad$ $\underline{1.19 \times 10^5 (2)}$

---

cap. Placas Paralelas

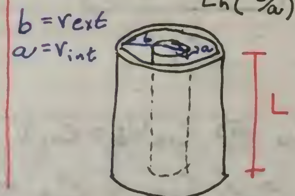
$C = \varepsilon_0 \dfrac{A}{d}$

Cap. Placas cilíndricas

$C = 2\pi\varepsilon_0 \dfrac{L}{\ln(b/a)}$

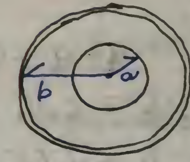
$b = r_{ext}$

$a = r_{int}$



Cap. Placas Esféricas 25/8/14

$C = 4\pi\varepsilon_0 \dfrac{ab}{b-a}$

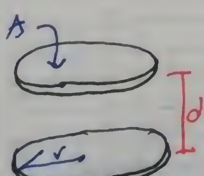


24.6)

$C = 10.0 \, \mu F$

$V = 12.0 \, V$

$C = \dfrac{q}{V} \Rightarrow V = \dfrac{q}{C}$



a) 12 V

b) i) d se duplica $\quad V = ?$ $\qquad$ ii) r se duplica $\quad V = ?$

i) $V = \dfrac{q}{c} \Rightarrow V' = \dfrac{q}{c/2} \Rightarrow V' = 2\dfrac{q}{C}$

$V' = 2(V) = 2(12) = \underline{24V}$

ii) $C = \dfrac{q}{V} \Rightarrow V = \dfrac{q}{C} \Rightarrow V_1 = \dfrac{q}{4C}$

$A = \pi r^2$

$A_1 = \pi(2r)^2$

$A_1 = \pi 4 r^2$

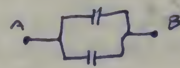
$A_1 = 4\pi r^2$

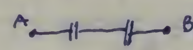
$A_1 = 4A$

$V_1 = \dfrac{1}{4}\left(\dfrac{q}{C}\right) = \dfrac{1}{4} V = \dfrac{1}{4}(12) = \underline{3V}$

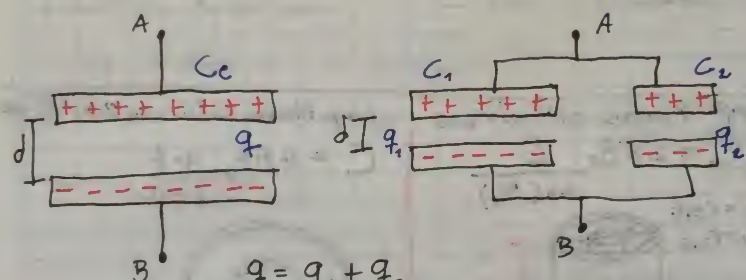
Tarea 24... 1, 3, 5, 7, 9

Capacitores conectados entre sí:

Conexión en Paralelo 

Conexión en Serie 

Capacitores en Paralelo



En Paralelo Dif de Pot va a ser la misma

$$q = q_1 + q_2$$

$$C_e V_e = C_1 V_1 + C_2 V_2 \Rightarrow C_e V = C_1 V + C_2 V$$

$$C_e V = V(C_1 + C_2) \Rightarrow C_e = C_1 + C_2$$

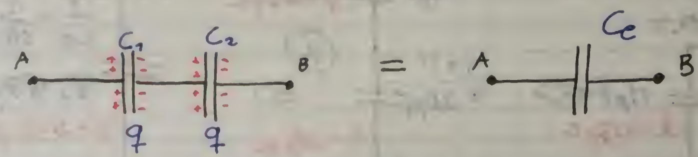
$$\text{ó } C_e = \sum_{i=1}^{n} C_i$$

$$q = q_1 + q_2 + \dots q_n$$

$$C_e = C_1 + C_2 \dots C_n$$

$$V = V_1 = V_2 = V_n$$

Capacitores en Serie:



$$V = V_1 + V_2$$

$$\frac{q}{C_e} = \frac{q}{C_1} + \frac{q}{C_2} \Rightarrow \frac{1}{C_e} = \frac{1}{C_1} + \frac{1}{C_2} \quad ó \quad \frac{1}{C_e} = \sum_{i=1}^{n} \frac{1}{C_i}$$

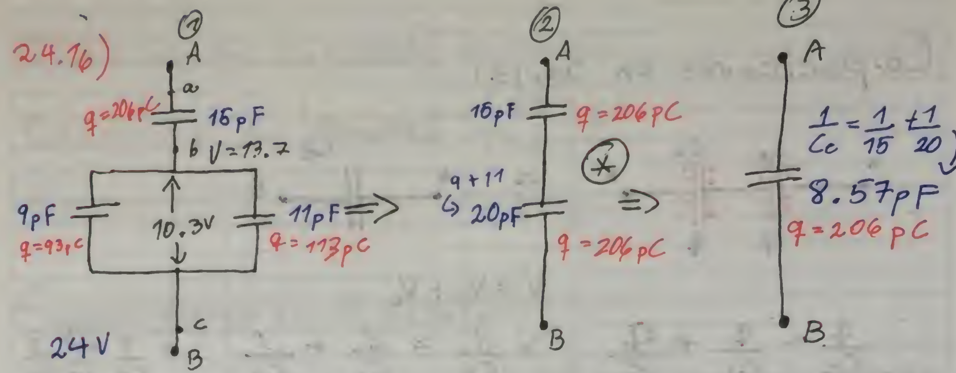
	En Paralelo	En Serie
Carga	$q = q_1 + q_2 \ldots$	Igual
Capacitancia	$C_e = C_1 + C_2 \ldots + C_n$	$\frac{1}{C_e} = \frac{1}{C_1} + \frac{1}{C_2} \cdots \frac{1}{C_n}$
Dif. Potencial	$V_1 = V_2 = V_n$	$V = V_1 + V_2 + \ldots$

En paralelo C_e tiene que ser mayor que C_{mayor}

En serie C_e tiene que ser menor que C_{menor}

~~En~~ paralelo 24... 17, 19, 21

24.16)



③ $C=\frac{q}{V} = q = CV \Rightarrow q_e = C_e V = (8.57 \times 10^{-12})(24) = 206\,pC$

(*) para comprobar $\Sigma = 24$ en este caso

② $= \left(\_\_\right) \times 10^{-12} + \left(\frac{206}{20}\right) \times 10^{-12} = 24.0\,V$

$V_1 = 13.7 \quad + \quad V_2 = 10.3\,V \quad = 24\,V$

① $q = CV$

$q_1 = CV = 11 \times 10^{-12} * 10.3\,V = 113\,pC$

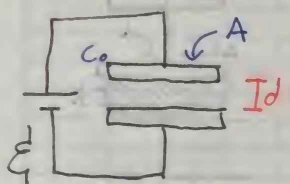
$q_2 = CV = 9 \times 10^{-12} * 10.3\,V = 92.7\,pC \approx 93\,pC$

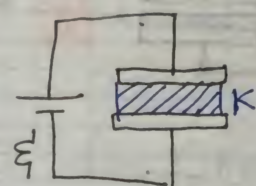
Comprobando $q_e = q_1 + q_2 = 113 + 93 = 206\,pC$ ✓

1/9/14

Capacitores con dieléctricos

1) Con Fuente conectada.





Cuando está conectada aumenta K veces

$$q_0 = C_0 V$$

$$C_0 = \varepsilon_0 \frac{A}{d}$$

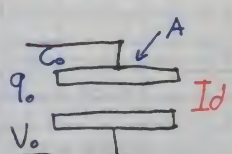
$$q = CV = K C_0 V$$

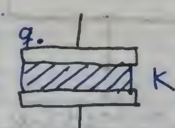
$$q = K q_0$$

$$C = K \varepsilon_0 \frac{A}{d}$$

$$C = K C_0$$

2) Con Fuente desconectada





Desconectada se reduce K veces

$$C = \frac{q_0}{V_0}$$

$$V = \frac{q_0}{C_0}$$

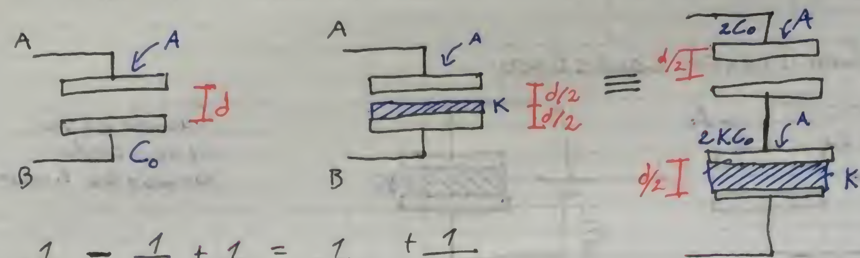
$$C = K C_0$$

$$V = \frac{q_0}{C}$$

$$V = \frac{q_0}{K C_0} = \frac{1}{K} \frac{q_0}{C_0} = \frac{1}{K} V_0$$

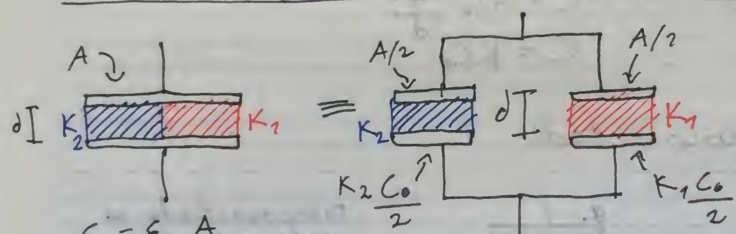
$$V = \frac{V_0}{K}$$

Llenado Parcial



$$\frac{1}{C_e} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{2C_0} + \frac{1}{2KC_0}$$

$$\frac{1}{C_e} = \frac{K+1}{2KC_0} \Rightarrow C_e = \frac{2KC_0}{K+1} = \frac{2K}{K+1}\, C_0$$



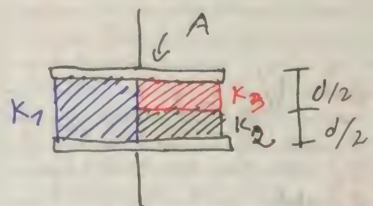
$$C_0 = \varepsilon_0 \frac{A}{d}$$

$$C_e = C_1 + C_2$$

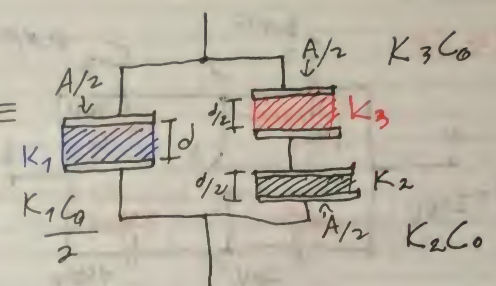
$$C_e = \frac{K_1 C_0}{2} + \frac{K_2 C_0}{2}$$

$$C_e = \frac{C_0}{2}(K_1 + K_2)$$

$$C_e = \left(\frac{K_1 + K_2}{2}\right) C_0$$



$\equiv$



$$\frac{1}{C_e} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{K_2 C_0} + \frac{1}{K_3 C_0}$$

$$\frac{1}{C_e} = \frac{K_3 + K_2}{K_3 K_2 C_0} \Rightarrow C_e = \left(\frac{K_2 K_3}{K_2 + K_3}\right) C_0$$

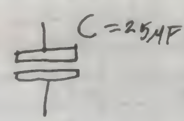
$$C_e = C_1 + C_2 \qquad C = \varepsilon_0 \frac{A/2}{d/2} = \varepsilon_0 \frac{A}{d}$$

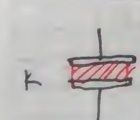
$$C_e = \frac{K_1 C_0}{2} + \frac{K_2 K_3}{K_2 + K_3} C_0 \Rightarrow C_e = C_0 \left(\frac{K_1}{2} + \frac{K_2 K_3}{K_2 + K_3}\right)$$

$C = 25\mu F$

$V = 12.0V$

$K = 2.50$





$$C = \frac{q}{V} \Rightarrow q = CV$$

$$q = (25\times10^{-6})(12) = 300\,\mu C$$

$$U_0 = \frac{q^2}{2C_0} = \frac{(300\times10^{-6})^2}{2(25\times10^{-6})} = 1.80\text{ mJ}$$

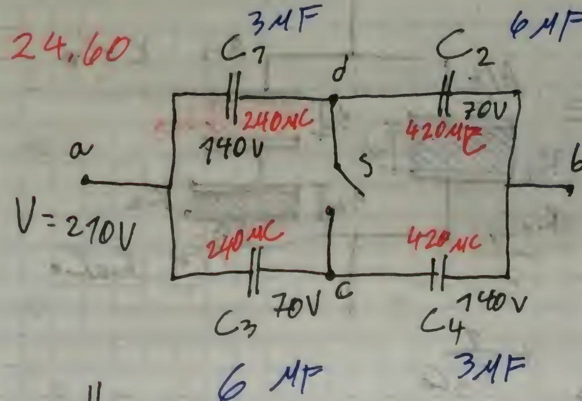
$$U_F = \frac{q^2}{2C_0} = U_c = 0.720\text{ mJ}$$

$$W = \Delta U \Rightarrow U_F - U_0$$

$$W = (0.720\times10^{-3}) - (1.80\times10^{-3})$$

$$W = -1.08\times10^{-3}\text{ J}$$

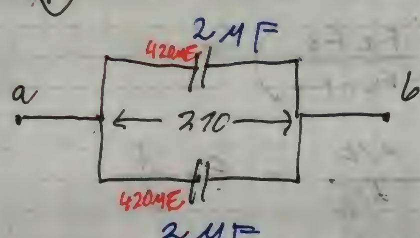
24.60



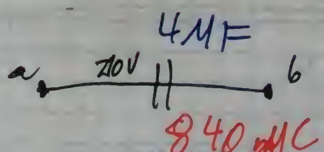
a) $V_{cd} = ?$

b) V_c/cap

con S. cerrado



$$\frac{1}{C_e} = \frac{1}{3} + \frac{1}{6}$$

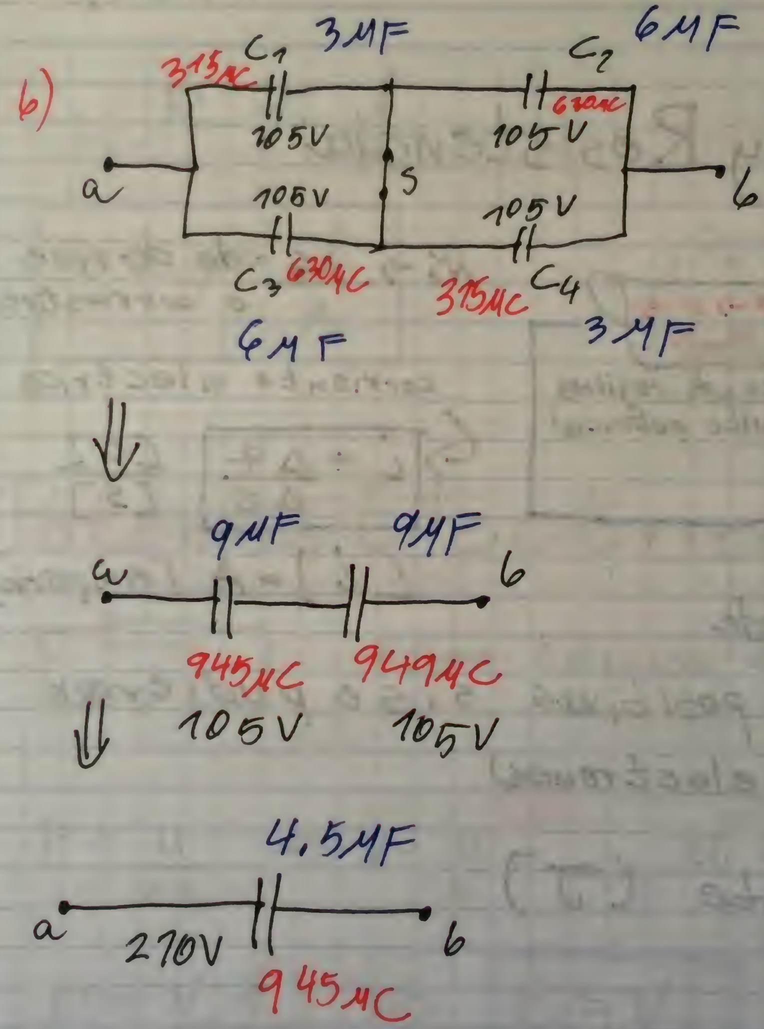


$$V_1 = \frac{q_1}{C_1} = \frac{420\,\mu C}{3\,\mu F}$$

$$V_{cc} = V_c - V_d = 70 - 140 = -70\,V$$

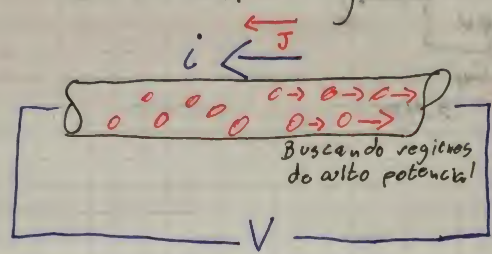
24.. 61, 59, 63, 65

b)



5/9/14

Corriente y Resistencia



$\vec{v}_d \rightarrow v_d$ = de derive o arrastre

corriente eléctrica

$$\boxed{i = \frac{\Delta q}{\Delta t}} \quad \frac{[C]}{[s]}$$

$[i] = A$ [Amperio]

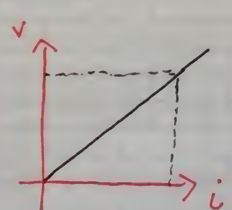
La corriente va adonde se moverían las cargas positivas si se pudieran mover. (En contra de electrones)

- Densidad de corriente (J)

$$J = \frac{i}{A} \quad \frac{[Amp]}{[m^2]}$$

$$\bar{J} = n\,q\,\bar{v}_d$$

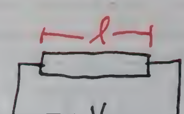
n = No. electrones libres
q = carga
$\bar{v}_d$ = velocidad de arrastre



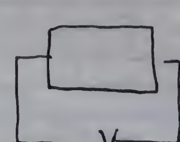
(R)

La pendiente es la resistencia eléctrica del material

$$R = \frac{V}{i} \quad \frac{[V]}{[Amp]} \Rightarrow [ohm] \Rightarrow \Omega$$



$R \propto l$



$R \propto \frac{1}{A}$

Resumen cap 25

$$\therefore \; R \propto \frac{l}{A}$$

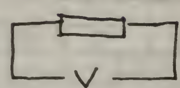
$$\boxed{R = \rho \frac{l}{A}}$$

ρ = Resistividad material

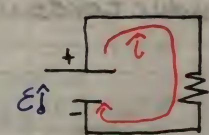
Tabla 25.1 P.823

Potencia Eléctrica

8/9/14



Forma técnica $\Rightarrow$



$$P = \frac{U}{\Delta t} \Rightarrow V = \frac{U}{q} \Rightarrow U = Vq$$

$$P = V\frac{q}{\Delta t} \Rightarrow \boxed{P = Vi}$$

$$R = \frac{V}{i} \Rightarrow V = iR \Rightarrow i = \frac{V}{R}$$

$$P = Vi \Rightarrow P = (iR)\,i$$

$$\boxed{P = i^2 R}$$

$$P = Vi \Rightarrow P = V\left(\frac{V}{R}\right) \Rightarrow \boxed{P = \frac{V^2}{R}}$$

ej) Luces en clase $\quad P = Vi$

$P = 1{,}600\,W \qquad i = \frac{P}{V} = \frac{1{,}600\,W}{110\,V} = 14.5\,A$

$$\Delta\rho = \rho_0 \alpha (T - T_0) \rightarrow T_0 = 20°C \cdot \text{Temp ambiente}$$

$$\rho - \rho_0 = \rho_0 \alpha (T - T_0)$$

$$\boxed{\rho = \rho_0 (1 + \alpha \Delta T)}$$

$$\rho \frac{L}{A} = \rho_0 \frac{L}{A} (1 + \alpha \Delta T) \Rightarrow \boxed{R = R_0 (1 + \alpha \Delta T)}$$

Superconductores: materiales a temp muy baja

25.4)

Cobre $\rho = 1.72 \times 10^{-8} \Omega \cdot m$

$\phi = 1.02\ mm$

$J = 1.50 \times 10^6 \frac{A}{m^2}$

$n = 8.50 \times 10^{28}$

a) $i = ?$

b) $v_d = ?$

$$\frac{\pi D^2}{4} = \frac{\pi R^2}{2}$$

$$J = \frac{i}{A} \Rightarrow i = JA = \left(1.50 \times 10^6 \frac{A}{m^2}\right)\left(\frac{\pi (1.02 \times 10^{-3} m)^2}{4}\right)$$

$$i = 1.22 A$$

$$J = n q v_d \Rightarrow v_d = \frac{J}{nq} = \frac{1.50 \times 10^6}{(8.50 \times 10^{28})(1.6 \times 10^{-19})}$$

$$v_d = 0.110\ mm/s$$

25... 1, 3, 5, 11, 13

25.14)

$L = 6.50\,m$ a) $\rho = ?$ (material)

$\phi = 2.05\,mm$ b) $R = ?$ a $150°C$

$R = 0.0290\,\Omega$

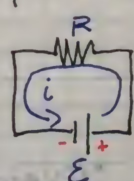
$$R = \rho \frac{L}{A} \Rightarrow \rho = R\frac{A}{L} = (0.0290)\frac{(\pi(0.00205)^2)}{4(6.50)}$$

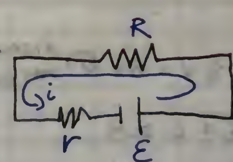
$$\rho = 1.47 \times 10^{-8}\,\Omega\,m \Rightarrow \text{Plata}$$

$$R = R_0(1 + \alpha\,\Delta T)$$

$$R = 0.0290\,\Omega\,(1 + 0.0038\,(\underbrace{130°}_{\Delta T = 150-20})) = 0.043\,\Omega$$

Aparatos de Medición





$V = iR$

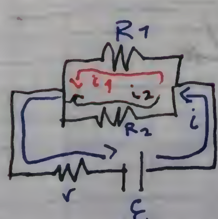
$\varepsilon - iR = 0$

$\varepsilon = iR$

$\varepsilon - iR - ir = 0$

$\varepsilon = iR + ir$

$\varepsilon = i(R + r)$

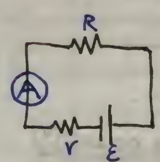


$i = i_1 + i_2$

25 .. 25, 29 , 31, 33 , 36

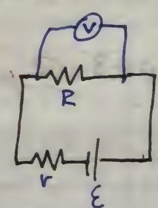
·Amperímetro:

Mide corriente, se conecta en serie



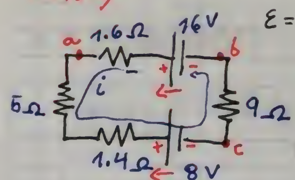
$R_A \to 0$ Para no interferir

·Voltímetro:



$R_V \to \infty$ Para que no afecte

25.32)



$\varepsilon = 16V - 8V = 8V$ dirección más grande

a) $i = ?$

b) V_{ab}

c) V_{ac}

a) $\varepsilon = i \Sigma R$

$i = \dfrac{8\,V}{(1.6+5+1.4+9)}$

$i = 0.471 \text{Amp}$

"i" va al otro sentido

$V_a - 1.6(-0.471) - 16 = V_b$

$V_a - 15.2 = V_b$

inverso

b) $V_b + \overset{V}{16V} - \overset{iR}{(0.471)(1.60)} = V_a$

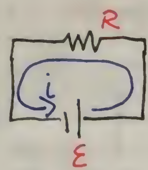
$V_b + 15.2 = V_a \implies V_a - V_b = 15.2\,V$

c) $V_a - 1.6(-0.471) - 16 - 9(-0.471) = V_c$

$V_a - 11.0 = V_c \implies V_a - V_c = 11.0V$

$= V_a - 5(0.471) - 1.4(0.471) - 8 = V_c$

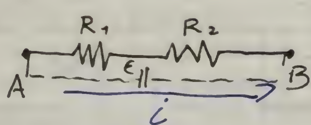
Circuitos de Corriente Directa



$R = \frac{V}{i}$

Conexiones en serie y paralelo

Resistencia en Serie



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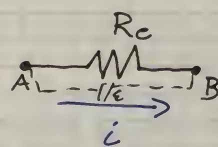
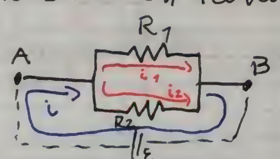


Caída de Potencial

↳ $V_e = V_1 + V_2 \Rightarrow i R_e = i R_1 + i R_2$

$\Rightarrow \boxed{R_e = R_1 + R_2}$ En serie

Resistencia en Paralelo



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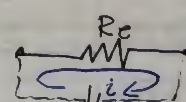


$i_e = i_1 + i_2$

$V = V = V$

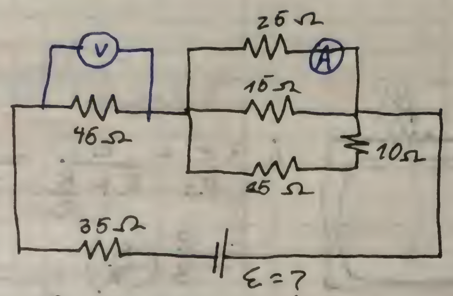
$$\frac{V}{R_e} = \frac{V}{R_1} + \frac{V}{R_2}$$

↳ $$\boxed{\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2}}$$

↳ $$\frac{1}{R_e} = \sum_{i=1}^{n} \frac{1}{R_i}$$

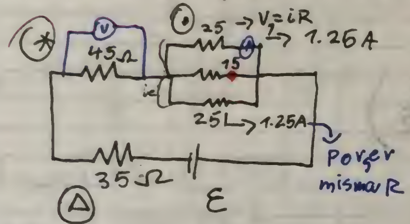
26... Resúmen

26.6)



$i = 1.25A$

≡



$V_1 = iR = (1.25)(25) = 31.25\,V$ //

↳ En todas las que están en paralelo

$i = \frac{V}{R} = \frac{31.25}{15} = 2.08\,Amp$

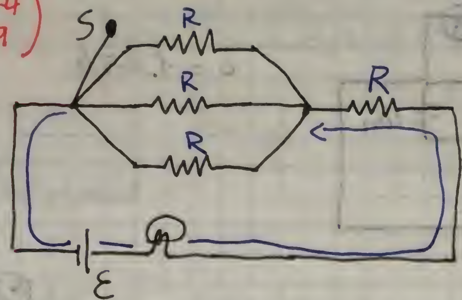
$i_e = 1.25 + 1.25 + 2.08 = 4.58\,Amp$

(*) $V = iR = (4.58)(45) = 206.25\,V$ //

(△) $V = iR = (4.58)(35) = 160.3$ //

$\varepsilon = 31.25 + 206.25 + 160.3 = 397.8\,V$ //

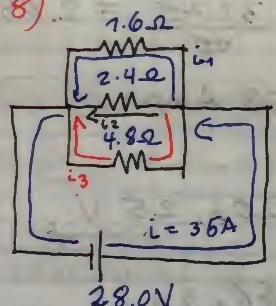
P874) 26.9)



$$i = \frac{\varepsilon}{R_e} = \frac{\varepsilon}{R + \frac{R}{2}} = \frac{2\varepsilon}{3R} = \frac{2}{3}\left(\frac{\varepsilon}{R}\right)$$

$$i = \frac{\varepsilon}{R_e} = \frac{\varepsilon}{R + \frac{R}{3}} = \frac{3}{4}\left(\frac{\varepsilon}{R}\right)$$

26.8)

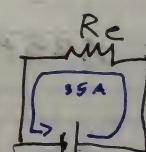


a) $R_e = ?$

b) $i_{c/R} = ?$

c) $i_{Tot} = ?$

=



Es Mas pequeña que la mas pequeña

$$\frac{1}{R_e} = \frac{1}{1.6} + \frac{1}{2.4} + \frac{1}{4.8} \Rightarrow R_e = 0.800\Omega$$

$$i = \frac{V}{R} = \frac{\varepsilon}{R} \Rightarrow i = \frac{28.0\,V}{0.800\,\Omega} = 35.0\,A$$

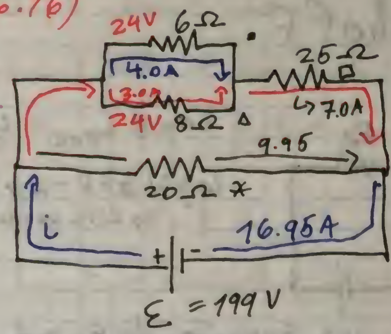
$$i_1 = \frac{\varepsilon}{R_1} = \frac{28.0}{1.60} = 17.5 \; ; \quad P_1 = V i_1 = (28)(17.5) = 490\,W$$

$$i_2 = \frac{\varepsilon}{R_2} = \frac{28.0}{2.4} = 11.67 \; ; \quad P_2 = V i_2 = (28)(11.6) = 326.76\,W$$

$$i_3 = \frac{\varepsilon}{R_3} = \frac{28.0}{4.8} = 5.83 \; ; \quad P_3 = V i_3 = (28)(5.8) = 163.24\,W$$

26... 1, 3, 5, 9, 11, 13

26.16)



$* \quad i = \frac{V}{R} = \frac{199}{20} = 9.95$

$i_{Tot} = (7A) + (9.95A)$

$i_{Tot} = \underline{16.95A}_{\#}$

a) $i_{20} \to ? \quad 9.95 A$

$i_{25} = ? \quad 7A \to 4+3$

$\bullet \; V = iR = (4)(6) = 24V$

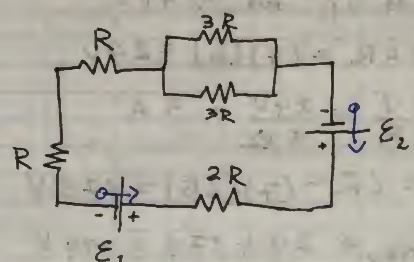
$\triangle \; i = \frac{V}{R} = \frac{24V}{8\,\Omega} = 3A$

$\square \; V = iR = (7)(25) = 175V$

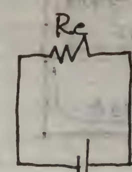
$V_{arriba} = 24 + 175 = 199V$

$\therefore V_{enmedio} \text{ y } \mathcal{E} = 199V$

Leyes de Kirchhoff.



$\equiv$



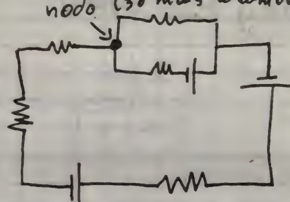
Ley 1) $i_{ent} = i_{sale}$

Ley 2) $\sum \uparrow P - \mathcal{E} \downarrow P = 0$

↳ Circ cerrado

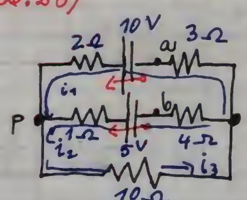
↳ Suponiendo $\mathcal{E}_1 > \mathcal{E}_2$

nodo (3 o más alambres que concurran)



Ya no se puede ya que las FEM no están en la misma línea

26.28)



$$i_1 + i_2 = i_3 \quad ①$$
$$i_1 + i_2 - i_3 = 0$$

②
$$V_p - 10i_3 - 3i_1 + 10 - 2i_1 = V_p$$
$$10 - 10i_3 - 5i_1 = 0 \implies i_1 + 2i_3 = 2$$

③
$$-10i_3 - 4i_2 + 5 - 1i_2 = 0$$
$$5 - 10i_3 - 5i_2 = 0 \implies 2i_3 + i_2 = 1$$

26... 25, 27, 29

$$i_1 + i_2 - i_3 = 0$$
$$i_1 + \cancel{i_2} + 2i_3 = 0$$
$$i_2 + 2i_3 = 1$$

$$\left.\begin{aligned} \cancel{i_1} + i_2 - i_3 &= 0 \\ -\cancel{i_1} \quad - 2i_3 &= 0 \end{aligned}\right.$$
$$\cancel{i_2} - 3i_3 = 0$$
$$-\cancel{i_2} - 2i_3 = -1$$
$$\cancel{-5i_3 = -3}$$
$$i_3 = 0.6$$

a)

$i_1 = 0.8\ A$

$i_2 = -0.2\ A \rightarrow$ Otro sentido

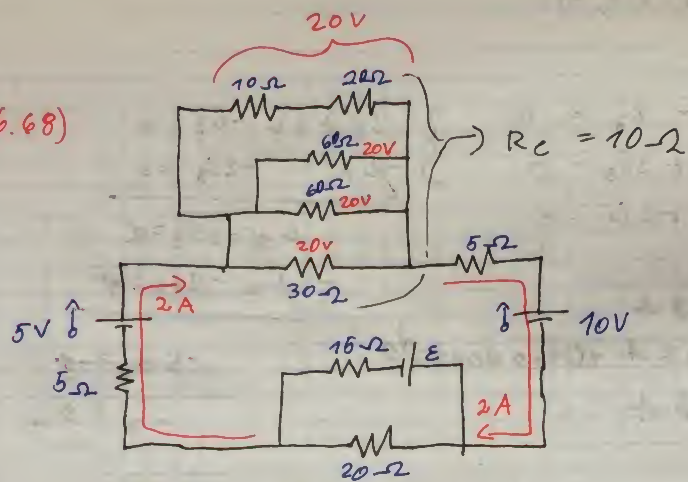
$i_3 = 0.6\ A$

b)

$$V_b - 4i_2 - 3i_1 = V_a$$
$$V_b - 4(0.20) - 3(0.8) = V_a$$
$$V_b - 0.80 - 2.40 = V_a$$
$$V_b - V_a = 3.2\ V$$

26... 33, 61, 63, 65, 66

26.68)



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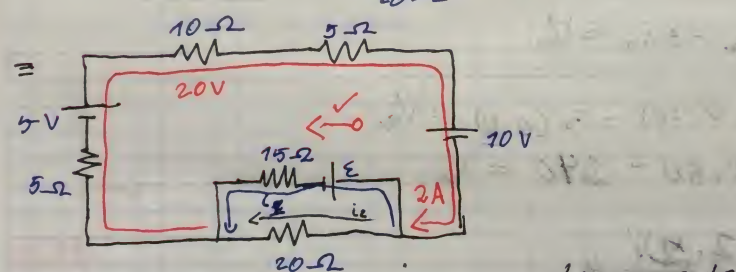


$\longrightarrow i_2$ sentido correcto

$i_1 + i_2 = 2$

$-\cancel{2}(5+10+5)$ De la parte igual

$-2(20) + 5 - 10 - 20 i_2 = 0$

$\Rightarrow i_2 = -2.25A \quad \therefore \; i_1 = 4.25 \text{ A}$

$-20(2.25) - \varepsilon - 15(4.25) = 0$

$\Rightarrow \varepsilon = -108.75V$

b) 60 J $\quad t = ?$

$10 i + 20 i = 20$

$i(10+20) = 20$

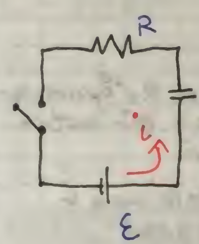
$i = \frac{20}{10+20} = 0.67 A$ //

$P = i^2 R = (0.667)^2 (10) = 4.44W$

$P = \frac{W}{\Delta t} \Rightarrow \Delta t = \frac{W}{P} = \frac{60 J}{4.44 W} = 13.64 s$ //

Circuito abierto capacitor actúa como alambre
Capacitor cargado actúa como alambre cortado

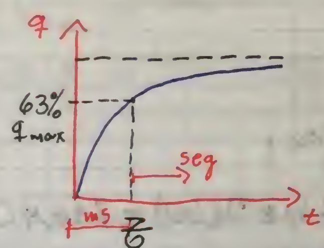
Circuitos RC



$t = 0$
$q = 0$
$i = i_{max} = \frac{\mathcal{E}}{R}$

$t \to \infty$
$q = C\mathcal{E}$
$i = 0$

Gráfica característica de un circuito RC



$\tau \Rightarrow$ constante capacitiva de tiempo

magnitud $\langle \tau \rangle = \underset{R}{10^3} * \underset{C}{10^{-6}} = 10^{-3}\,s$
$\approx ms$

Si dicen tiempo en seg $= q_{max}$

$\tau = RC$

$q = C\mathcal{E}\,(1 - e^{-t/RC})$

$e^{-t/RC}$ cuando $t \to \infty = 0$

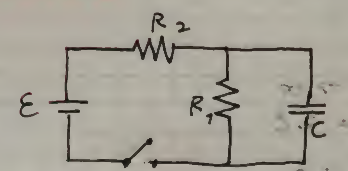
$i = i_{max}\, e^{-t/RC} \Rightarrow \frac{\mathcal{E}}{R} e^{-t/RC}$

$q = q_{max}\, e^{-t/RC}$ $\quad q_{max} = C\mathcal{E}$

$i = -\frac{\mathcal{E}}{R} e^{-t/RC}$ → descarga
(no hay $\mathcal{E}$)

26... 41, 43, 45

25.83)



En $t=0$

$q=0$

$i=\frac{\mathcal{E}}{R_2}$ → Debido a que R_1 se opone a la corriente y el C actúa como alambre

En $t \to \infty$

i_R → Ya que está en paralelo con C y en paralelo V es igual

$q = CV = C\left(\frac{\mathcal{E}}{R_1+R_2}\right)R_1$

$i = \frac{\mathcal{E}}{R_1+R_2}$

26.42)

$C = 12.4\ \mu F$

$R = 0.895\ M\Omega$

$V = 60.0\ V$

q a→ a) $t = 0.0\ s$
b) $t = 5.0\ s$
c) $t = 10.0\ s$
d) $t = 20.0\ s$
e) $t = 100.0\ s$

a) $q = q_{max}(1-e^{-t/RC})$

$q_{max} = C\mathcal{E} = (12.4\times10^{-6})(60) = 744\ \mu C$

$RC = (0.895\times10^{6})(12.4\times10^{-6}) = 11.1\ s$

$q = 0$

b) $q = (744\times10^{-6})(1-e^{-5/11.1}) = 2.70\times10^{-4}$

c) $q = (744\times10^{-6})(1-e^{-10/11.1}) = 4.48\times10^{-4}$

d) $= 6.21\times10^{-4}$

e) $= 7.4\cancel{4}\times10^{-4}$

29/9/14

P 878
26.46)

$C = 1.50\,\mu F$

$R = 12.0\,\Omega$

$\mathcal{E} = 10.0\,V$

$i = ?$

con $q = \frac{1}{4} q_{max}$

$$q = q_{max}\left(1 - e^{-t/RC}\right)$$

$$0.25\,q_{max} = q_{max}\left(1 - e^{-t/RC}\right)$$

$$0.75 = e^{-t/RC}$$

$$e^{t/RC} = \frac{1}{0.75} \Rightarrow \frac{t}{RC} = \ln\left(\frac{1}{0.75}\right)$$

$$t = RC\ln\left(\frac{1}{0.75}\right) = (12)(1.5\times10^{-6})\ln\left(\frac{1}{0.75}\right)$$

$$t = 5.18\,\mu s$$

$$i = i_{max}\, e^{-t/RC}$$

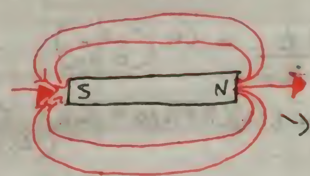
$$i = \frac{\mathcal{E}}{R} e^{-t/RC} = \frac{10}{12} e^{-(5.18\times10^{-6})/(12)(1.5\times10^{-6})} = 0.625\,A$$

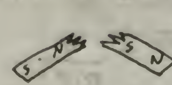
P2

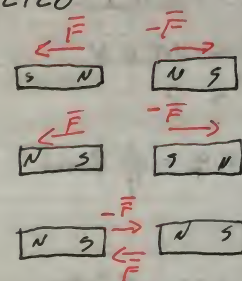
Res 27 / 26... 47, 49

Magnetismo

Atracciones de material Ferromagnético





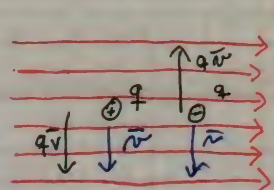


Campo Magnético: $\overline{B}$

(Gauss $= 10^{-4}$ Teslas)

$[\overline{B}] =$ Tesla

- Efecto sobre una partícula cargada



$\overline{F}_B$ → saliendo (+)

Si está quieta no pasa nada
si se mueve actúa sobre q fuerza magnética

$$\overline{F}_B = q\,\overline{v} \times \overline{B} \quad (\operatorname{sen} \theta)$$

↳ Producto Cruz

↳ $\overline{F}_B$ = Perpendicular a ambos.

↳ Regla mano derecha

27.2)

$m = 0.195 g$

$q = -2.5 \times 10^{-8} C$

$\bar{v} = 4.00 \times 10^4 \frac{m}{s}$ Norte

$\bar{B} = ?$

$F_B = q \bar{v} \times \bar{B}$

$mg = q v B$

$B = \frac{mg}{qv}$

$B = \frac{0.195 \times 10^{-3} (9.8)}{2.5 \times 10^{-8} \times 4 \times 10^4}$

$B = 1.9 \, T$ Este

27.8)

$q = -5.6 \mu C$

$\bar{B} = -1.25 T$

$F_B = [-3.4 \times 10^{-7} i - 7.4 \times 10^{-7} j] N$

a) $\bar{v} = ?$ $F_B = q v \times B$

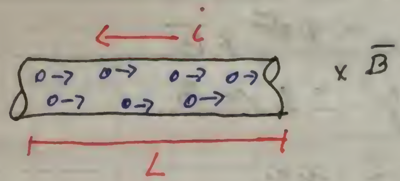
$$F_B = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ v_x & v_y & v_z \\ B_x & B_y & B_z \end{vmatrix} q \Rightarrow [-3.4 \times 10^{-7} i - 7.4 \times 10^{-7} j] = \begin{vmatrix} i & j & k \\ v_x & v_y & v_z \\ 0 & 0 & -1.25 \end{vmatrix} (-5.6 \times 10^{-6})$$

$-3.4 \times 10^{-7} i - 7.4 \times 10^{-7} j = 1.25 \times 10^{-2} v_z i - 1.24 \times 10^{-6} v_x j$

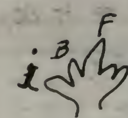
$$v_y = \frac{-3.40 \times 10^{-7}}{1.25 \times 5 \times 10^{-2}} = -48.6 \, m/s$$

$$v_x = \frac{7.40 \times 10^{-7}}{1.25 \times 5.6 \times 10^{-9}} = 106 \, m/s$$

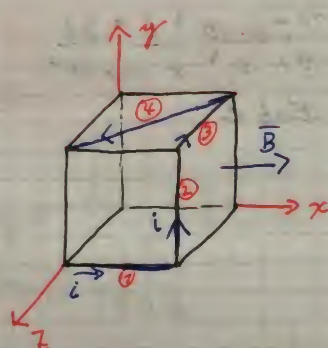
www. pearsoneducacion.net / giancoli
companion website "practiceproblems" 6/10/14



$$\bar{F} = i\bar{L} \times \bar{B}$$



Ej)



$i = 2.50\,A$

$l = 0.200\,m$

$\bar{B} = 0.850T\,\hat{\imath}$

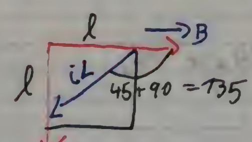
$F_{B1} = 0$ por ser perpendiculares $(0°)$

$\overline{F_{B2}} = i\bar{l} \times \bar{B}$ sen $90° = (2.50)(0.2)(0.85)$ sen $90°$

$\bar{F}_{B2} = -0.425\,N\,\hat{k}$

$\bar{F}_{B3} = i\bar{l} \times \bar{B}$ sen $90 = 0.425\,N\,(-\hat{\jmath})$

$\bar{F}_{B4} = il \times B$ sen $135° = 2.50 * 0.200\sqrt{2} * 0.850$ sen 135



$\bar{F}_{B4} = 0.425\,N\,(+\hat{\jmath})$

P 27... ~~dudas~~ hojas

8/10/14

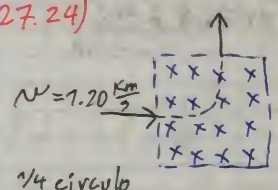
Partículas en un campo magnético constante

(Mov Circ Unif)

$$\bar{F}_B = \bar{F}_c \Rightarrow q\,\bar{v} \times \bar{B} = m\bar{a}_c$$

$$q v B = m\frac{v^2}{r} \Rightarrow \boxed{qBr = mv}$$

27.24)



$d = 1.18cm$ $\quad m_p = 1.67 \times 10^{-27}\,Kg$

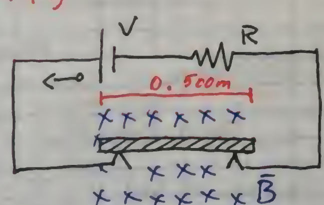
$B = ?$

$$B = \frac{mv}{qr}$$

$$\frac{\pi r}{2} = 1.18cm \Rightarrow r = \frac{2(1.18)}{\pi} = 0.75\,cm$$

$$B = \frac{(1.67\times10^{-27}Kg)(1.20\times10^{3}m/s)}{(1.6\times10^{-19})(0.75\times10^{-2}m)} = 1.67\times10^{-3}\,T$$

27.41)



$l = 0.500\,m$ $\quad R = 25.0\,\Omega$

$m = 0.750\,kg$ $\quad$ a) $\mathcal{E} = ?$

$B = 0.450\,T$

a) $F_B = F_g$

$q v B^{\,sen 90} = mg$

$i l B = mg$

$i = \frac{mg}{lB}$

$i = \frac{(0.750)(9.8)}{(0.5)(0.450)}$

$i = 32.7A$

$V = iR$

$V = (32.7)(25)$

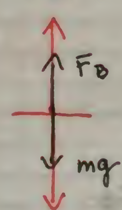
$V = 817.5\,V$

15 en hoja R_4 200

b) $i = \dfrac{\varepsilon}{R} = \dfrac{817.5\,V}{2\,\Omega} = 408.75\,A$

$F_B = i l B = (408.75A)(0.500m)(0.450T)$

$F_B = 91.97\,N$



$F_B - mg = ma \Rightarrow a = \dfrac{F_B - mg}{m}$

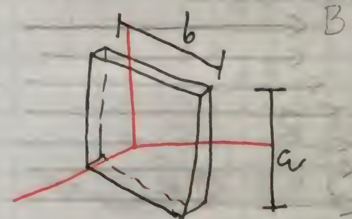
$a = \dfrac{91.97 - (0.750)(9.8)}{0.750} = 112.87\,m/s^2$

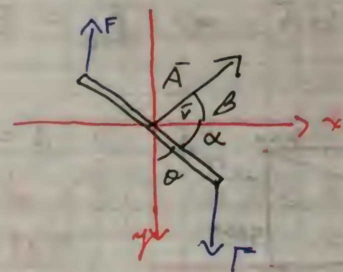
Hoja 14) $q = q_{max}\left(1 - e^{-t/RC}\right)$

$0.1 = \left(1 - e^{-n \cancel{RC}/\cancel{RC}}\right)$

$0.9 = e^{-n}$

Una Esfera dentro de un Campo Magnético Constante





$$F_1 = i\,l \times B$$
$$F_1 = i\,a\,B \text{ sen } 90^\circ$$
$$F_1 = i\,a\,B = F_2$$

$$\Sigma \bar{\tau} = \bar{\tau} \Rightarrow \bar{\tau}_R = \bar{\tau}_1 + \tau_2$$
$$\tau_R = r_1 \times F_1 + F_2 \times r_2$$
$$\tau_R = \left(\frac{b}{2}\, i\, a\, B \text{ sen}\theta\right)2 = i\,A\,B \text{ sen}\theta$$

Donde iA = momento dipolar magnético

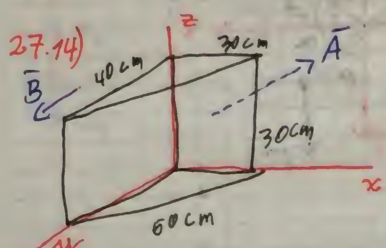
$$\bar{\mu} = i\bar{A} = N i \bar{A} \qquad N = \text{número de vueltas}$$
$$\tau_R = \mu B \text{ sen}\theta$$
$$\bar{\tau} = \bar{\mu} \times \bar{B}$$

27 ... 11, 13, 15, 25, 29, 39 13/10/14

Flujo Magnético

$$\Phi_B = \int B \cdot d\bar{A} \Rightarrow \Phi_B = \bar{B} \cdot \bar{A}$$

27.14)



$B = 0.128\ T\ \hat{k}$

a) $\Phi_{abcd} = ?$ c) $\Phi_{acnd} = ?$

b) $\Phi_{bcfe} = ?$ d) $\Phi_{Tot} = ?$

a) $\Phi = 0$ porque el ∢ entre $\bar{B}$ & $\bar{A}$ es 90°

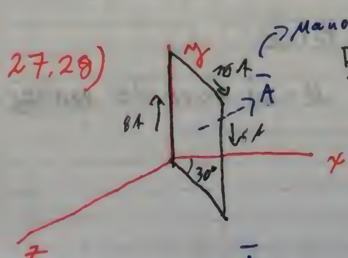
b) $\Phi = BA = (0.128T)(0.\ cm)^2 \text{ sen } 180°$

$\Phi = -0.0115\ Tm^2$

c) $\Phi = \bar{B} \cdot \bar{A} = BA \text{ sen } ∢ = (0.128)(0.30 \times 0.5)(3/5)$

$\Phi = 0.0115\ Tm^2$

27.28)



$B = 0.480 T\ \hat{i}$

Compuesta (n)

$$\bar{\tau} = \bar{\mu} \times \bar{B} = i\bar{A} \times \bar{B}$$

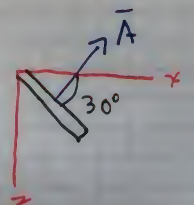
$$\bar{\tau} = iA\bar{B} \text{ sen } 60°$$

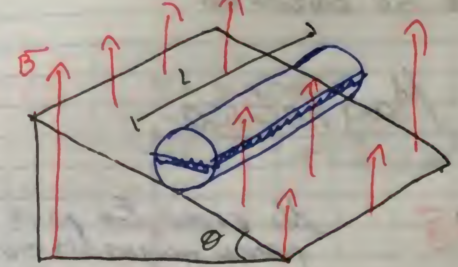
$$\bar{\tau} = (15)(0.08 \times 0.06)(0.480) \text{ sen } 60°$$

$$\tau = 0.03\ N.m$$

$$\tau = -0.03\ Nm\ \hat{y}$$

Planta:





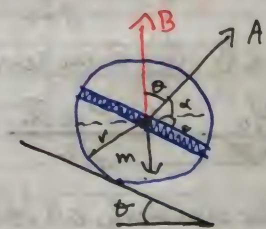
$m = 262\,g$

$L = 12.7\ cm$

$N = 13$ vueltas

$B = 477\,mT$

$i = ?$ para reposo



$\bar{\tau}_B = \mu \times \bar{B}$

Area espira (vect.)

$\bar{\tau} = N i \bar{A} \times \bar{B} = N i A B \operatorname{sen}\theta$

$\bar{\tau}_g = \bar{r} \times \bar{F}_g = r F_g \operatorname{sen}\theta$

$\bar{\tau}_g = r m g \operatorname{sen}\theta$

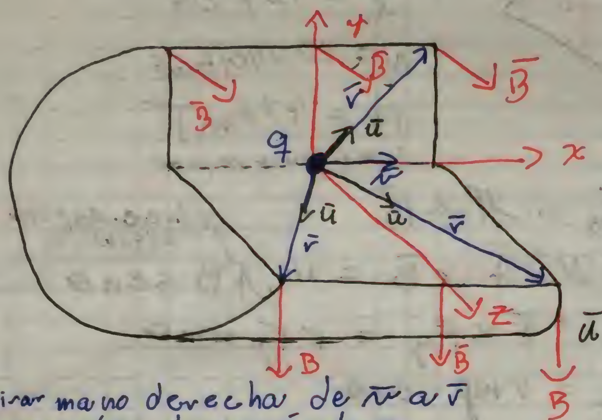
$$N i (2\cancel{r}L) B \cancel{\operatorname{sen}\theta} = m g \cancel{r} \cancel{\operatorname{sen}\theta}$$

$$2 N i L B = m g$$

$$i = \frac{mg}{2NLB} = \frac{(0.262)(9.8)}{2(13)(0.127)(0.477)} = \underline{1.63\,A}\ //$$

Cualquier partícula cargada en movimiento produce campo magnético en todo su entorno

Fuentes de Campo Magnético



Girar mano derecha de $\bar{v}$ a $\bar{r}$ para saber dirección de $\bar{B}$

μ_0 como ε_0 pero para magnetismo

$d = r$

$(\bar{B} \odot)\ \hat{k}$ en revés

$$\bar{B} = \frac{\mu_0}{4\pi}\ \frac{q\,\bar{v} \times \bar{u}}{d^2}$$

$\bar{u}$ = vector unitario en la dirección de $\bar{r}$

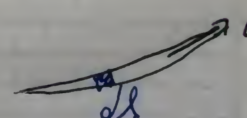
Cuando se trata de un segmento de conductor con corriente

Segmento muy Pequeño $\Longrightarrow$ $d\bar{B} = \dfrac{\mu_0}{4\pi}\ \dfrac{i\,d\bar{l} \times \bar{u}}{d^2}$

Ley de Biott & Savart (conductor muy largo) $\Longrightarrow$ $\bar{B} = \int d\bar{B} = \int \dfrac{\mu_0}{4\pi}\ \dfrac{i\,d\bar{l} \times \bar{u}}{r^2}$

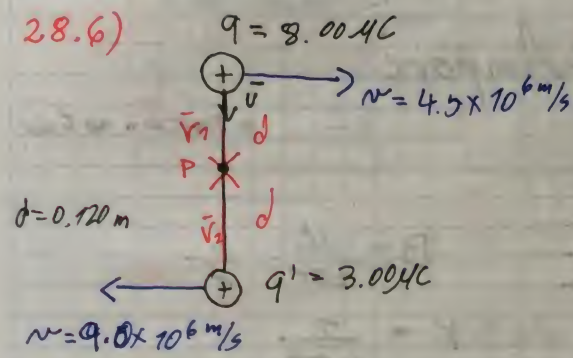
$$\bar{B} = \frac{\mu_0}{4\pi} \int \frac{i\,d\bar{l} \times \bar{u}}{r^2}$$

$\bar{u} = \dfrac{\bar{r}}{r}$



Resumen 27 y 28

28.6)



a)

$$B = \frac{\mu_0}{4\pi} \frac{q\vec{v} \times \vec{u}}{r^2}$$

$$B = B_1 + B_2$$

$$B = \frac{\mu_0}{4\pi}\left[\frac{8\times10^{-6} * 4.5\times10^{-6} \text{ sen} 90}{0.120^2} + \frac{3\times10^{-6} * 9\times10^{6} \text{ sen} 90^\circ}{0.120^2}\right]$$

$$B = 4.38\times10^{-4}\, T$$

$$\underline{B = -4.38\times10^{-4}\, T\ \hat{k}}\ _{//}$$

b)

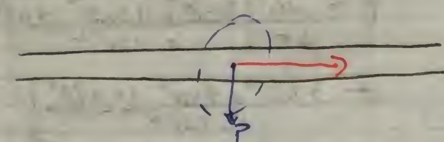
Magnitud B en cualquier recto $B = \frac{\mu_0}{2\pi} \frac{i}{d}$

B espira circular (Formulario)

Ley de Ampere

* Faltan notas

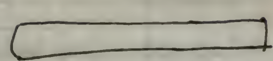
$$\oint B \cdot d\bar{s} = i_{ne} \mu_0$$



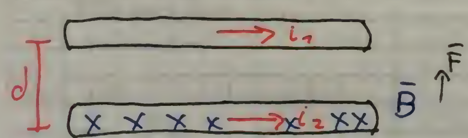
$$B = \frac{\mu_0}{2\pi} \frac{i}{d}$$

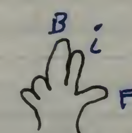
$$K = \frac{1}{4\pi\varepsilon_0}$$

$$K_B = \frac{\mu_0}{4\pi}$$



Fuerza magnética entre dos conductores rectos paralelos con corriente





$$B = \frac{\mu_0}{2\pi} \frac{i_1}{d}$$

$$\bar{F} = \bar{i}\bar{L} \times B$$

$$F_B = i_2 L B \operatorname{sen} 90$$

$$F_B = i_2 L \left(\frac{\mu_0}{2\pi} \frac{i_1}{d} \right) = \frac{\mu_0}{2\pi} \frac{i_1 i_2}{d} L$$

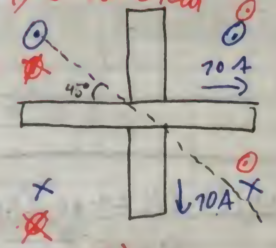
$$\frac{F_B}{L} = \frac{\mu_0}{2\pi} \frac{i_1 i_2}{d} \quad \left[\frac{N}{m} \right]$$

Corrientes en la misma dirección se atraen; opuesta se repelen

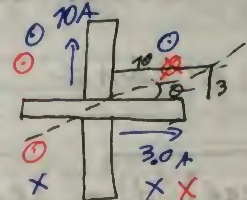
28... 59, 61, 63, 65

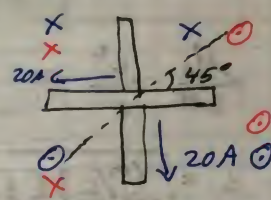
28.64) i Horizontal
i vertical

Girando mano derecha



a)

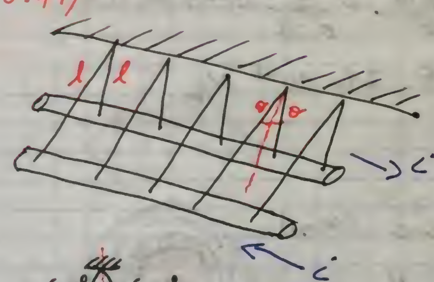




θ a la mas pequeña $\theta = \tan^{-1}\left(\frac{3}{10}\right)$

$$B_1 = \frac{\mu_0}{\cancel{2\pi}}\frac{i_1}{d_1} = \frac{\mu_0}{\cancel{2\pi}}\frac{i_2}{d_2} = B_2$$

28.71)

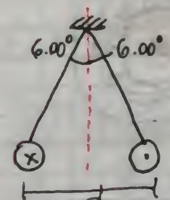


$l = 4.00\,cm$

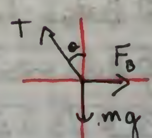
$\frac{m}{L} = 0.0125\ kg/m$

$\theta = 6°$

$i = ?$



$\Rightarrow$ D.C.L.



$\Sigma F_y = 0$

$T\cos\theta - mg = 0$

$T = \frac{mg}{\cos\theta}$

$\Sigma F_x = 0$

$F_B - T\,sen\,\theta = 0$

$F_B = T\,sen\,\theta \Rightarrow F_B = \frac{mg}{\cos\theta}\,sen\,\theta = mg\tan\theta$

$$\frac{F_B}{L} = \frac{m}{L}g\tan\theta \Rightarrow \frac{F_B}{L} = \frac{\mu_0}{2\pi}\frac{i_1 i_2}{d} \Rightarrow \frac{\mu_0}{2\pi}\frac{i^2}{d} = \frac{m}{L}g\,tg\theta$$

$d = 2(4 \operatorname{sen} 6°) = 0.836 \text{ cm}$

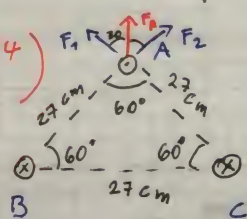
$$\frac{\mu_0}{2\pi}\frac{i^2}{d} = \frac{m}{L} g \tan\theta$$

$$i = \sqrt{\frac{(m/L)(g)(\tan 6)(d)}{\mu_0/2\pi}} = \sqrt{\frac{(0.0125)(9.8)(\tan 6)(0.00836)}{2\times 10^{-7}}}$$

$i = 23.2 \text{ A}$ #

T44 5)

$i = 8A$



$$\frac{F}{L} = \frac{\mu_0}{2\pi}\frac{\overset{(i_1\times i_2)}{i^2}}{l}\cos 30° * \underset{\text{simetría}}{2}$$

Ya que "x" se anulan

$$\frac{F}{L} = \frac{4\pi\times10^{-7}}{2\pi} * \frac{8^2}{0.27}(\cos 30)(2)$$

$$\frac{F}{L} = 8.21\times10^{-5} \text{ N/m}$$

T44 6)

$i_i = 1.00 \text{ A} \odot$

$i_e = 3.00 \text{ A} \otimes$

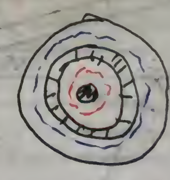
$B_a = ?$ a 8 mm

Ley de Ampere (Gauss)

$\oint \bar{B}\cdot d\bar{s} = i_{NE}\,\mu_0$

$\oint B\, ds \cos 0° = i_i \mu_0$

$B\oint ds = i_i \mu_0$



a)

$$B = \frac{\mu_0}{2\pi}\frac{i_i}{d_1} = \frac{4\pi\times10^{-7}}{2\pi}\frac{1}{8\times10^{-3}} = 2.5\times10^{-5} \text{ T}$$ #

b) $B\oint ds = (i_i + i_e)\mu_0$

$$B = \frac{4\pi\times10^{-7}}{2\pi}\frac{(\overset{i\,neta}{2A})}{20\times10^{-3}} = 2.0\times10^{-5} \text{ T}$$ #

27/10/14

Ley de Inducción de Faraday

Ley de Lenz

$$\mathcal{E} = -\frac{d\Phi_B}{dt} \rightarrow \text{Espira simple}$$

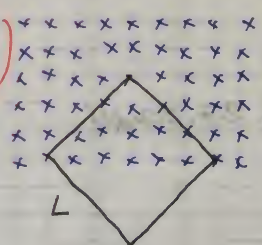
FEM inducida

$$\mathcal{E} = -N\frac{d\Phi_B}{dt} \rightarrow \text{Espira con N vueltas}$$

$$\mathcal{E} = N\frac{d(\bar{B}\cdot\bar{A})}{dt} = N\frac{d(BA\cos\theta)}{dt}$$

$$\mathcal{E} = NA\cos\theta\frac{dB}{dt}$$

T44
10)



$L = 8.4\ m$

$R = 80{,}0\ m\Omega$

$B = 0.042 \underbrace{-0.87t}_{dB/dt}$

$\Phi_B = ?$

$$\Phi = BA = (0.042)\frac{(8.4)^2}{2} = 1.48\ T\cdot m^2$$

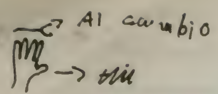
Ya que sólo la mitad está en el campo

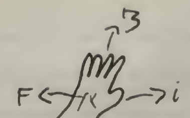
11) $\mathcal{E} = \overset{1}{N}\frac{d\Phi_B}{dt} = \frac{d(B\cdot A\cos\theta)}{dt} = A\cos 0^\circ\frac{dB}{dt}$

se mantienen igual

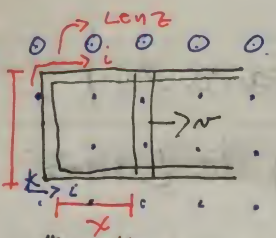
$$\mathcal{E} = \frac{(8.42)^2}{2}(-0.87) = 30.7$$

$$i = \frac{\mathcal{E}}{R} = \frac{30.7}{80\times10^{-3}} = 383\ A$$





T 44 14)



$$\mathcal{E} = \frac{d\Phi_B}{dt} \qquad v = 6.4\ m/s$$

$$\mathcal{E} = \frac{d\, B\, A \cos\theta}{dt}$$

$$\mathcal{E} = \underbrace{B \cos 0°}_{\text{No cambian}} \frac{dA}{dt} = B \frac{d Lx}{dt} = B L \frac{dx}{dt}$$

La velocidad es el cambio de distancia en cierto tiempo, es decir $v = \frac{dx}{dt}$

$$D^A\ \boxed{\mathcal{E} = B L v} = (2.58 \times 10^{-3})(0.50)(6.4\ m/s)$$

$$\mathcal{E} = 8.25 \times 10^{-3}\ V$$

15) $P = ?$

$$P = Vi = \frac{V^2}{R} = \frac{(8.25 \times 10^{-3})}{250 \times 10^{-3}} = 27.22\ mW$$

16) $F_B = iL \times B$

$$F_B = i L B \operatorname{sen}\overset{90°}{\theta} = \overset{i}{\frac{\mathcal{E}}{R}} L B$$

$$F_B = \frac{8.25 \times 10^{-3}}{250 \times 10^{-3}} (0.50)(2.58 \times 10^{3}) = 42.6 \times 10^{-6}\ N$$

$F_B = F_{Aplicar}$ (F_{mec})

↳ a la derecha

$$P = \frac{W}{\Delta t} = \frac{F \cdot \Delta x}{\Delta t} = F \cdot v$$

T 22

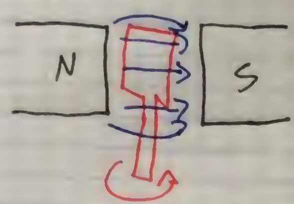
17 y 18

$$\mathcal{E} = NBA \frac{d \cos\theta}{dt}$$

$$\mathcal{E} = NBA \frac{d \cos \omega t}{dt}$$

$$\mathcal{E} = NBA\, \omega \operatorname{sen} \omega t$$

29/10/14



$$\varepsilon = \frac{d\Phi_B}{dt} = \frac{d(B\cdot A)}{dt} = \frac{d(BA\cos\theta)}{dt}$$

$$\varepsilon = BA\,\frac{d\cos\theta}{dt}$$

$x = vt \Rightarrow \theta = \omega t$

dirección

$$\varepsilon = BA\,\frac{d(\cos\omega t)}{dt} = BA(-\omega\ \mathrm{sen}\ \omega t)$$

T22 1)

$\omega = 2\pi F$

$N = 20$ vueltas $\qquad \varepsilon = BA\,\omega\ \overbrace{\mathrm{sen}\ \omega t}^{1}$

$r = 15\,cm \qquad \varepsilon = BA\omega N = \cancel{(40\times10^{-3})(\dots)}$

$B = 40\ mT \qquad \varepsilon = (40\times10^{-3})(\pi(0.150)^2)(2\pi(12))\,20$

$f = 12\ Hz \qquad \varepsilon = 4.26\,V \approx 4.3\,V$

$\varepsilon_{max} = ? \Rightarrow$ cuando $\mathrm{sen}\,\omega t = 1$

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Facultad de Ingeniería

Departamento de Física

Expresiones mas usadas en el curso de Física 2

$F = k\frac{q_1 q_2}{r^2}$ $k = 9x10^9 \frac{N-m^2}{C^2} = \frac{1}{4\pi\varepsilon_0}$ $i = \frac{dq}{dt}$ $E = \frac{F}{q}$ $E = k\frac{q}{r^2}$ $p = qd$ $E = k\frac{P}{x^3}$

$\lambda = \frac{q}{L}$ $\sigma = \frac{q}{A}$ $\rho = \frac{q}{Vol}$ $\tau = p \times E$ $U = -\bar{p} \bullet \bar{E}$ $\Phi_E = \Sigma \bar{E} \bullet \bar{A}$ $\Phi_E = \int \bar{E} \bullet d\bar{A}$

$\int \bar{E} \bullet d\bar{A} = \frac{q_{NE}}{\varepsilon_0}$ $E = \frac{\sigma}{\varepsilon_0}$ $E = \frac{\sigma}{2\varepsilon_0}$ $\Delta U = -W_{ab}$ $U_{(r)} = k\frac{q_1 q_2}{r}$ $V_p = \frac{U_p}{q_0}$ $E_s = -\frac{dV}{ds}$ $\Delta V = EL$

$V = k\frac{q}{r}$ $C = \frac{q}{V}$ $C = \varepsilon_0 \frac{A}{d}$ $C = 2\pi\varepsilon_0 \frac{L}{\ln(b/a)}$ $C = 4\pi\varepsilon_0 \frac{ab}{(b-a)}$ $C_{eq} = \sum_1^n C_n$ $\frac{1}{C_{eq}} = \sum_1^n \frac{1}{C_n}$ $C = k_e C_0$

$U = \frac{q^2}{2C}$ $u = \frac{U}{Ad}$ $R = \rho\frac{L}{A}$ $i = \frac{dq}{dt}$ $j = \frac{i}{A}$ $v_d = \frac{j}{nq}$ $R = \frac{V}{i}$ $\Delta\rho = \rho_0 \alpha (T - T_0)$ $P = iV$

V= EL

$P = i^2 R$ $P = \frac{V^2}{R}$ $R_{eq} = \sum_1^n R_n$ $\frac{1}{R_{eq}} = \sum_1^n \frac{1}{R_n}$ $q = C\varepsilon(1 - e^{-t/RC})$ $i = \frac{\varepsilon}{R} e^{-t/RC}$ $q = q_0 e^{-t/RC}$

$i = \frac{\varepsilon}{R} e^{-t/RC}$ $\tau_c = RC$ $\bar{F} = q\bar{v} \times \bar{B}$ $r = \frac{mv}{qB}$ $\bar{F} = i\bar{L} \times \bar{B}$ $\bar{\mu} = Ni\bar{A}$ $\bar{\tau} = \bar{\mu} \times \bar{B}$

$\bar{B} = \frac{\mu_0}{4\pi} \int \frac{i\bar{ds} \times \bar{r}}{r^3}$ $B = \frac{\mu_0 i}{2\pi r}$ $B = \frac{\mu_0 i}{2r}$ $\frac{F}{L} = \frac{\mu_0 i_1 i_2}{2\pi d}$ $\oint \bar{B} . \bullet \bar{ds} = \mu_0 i$ $B = \mu_0 i_0 n$ $B = \frac{\mu_0 i N}{2\pi r}$

$\Phi_B = \int \bar{B} \bullet \bar{dA}$ $\varepsilon = -\frac{d\Phi_B}{dt}$ $\varepsilon = -N\frac{d\Phi_B}{dt}$ $\varepsilon = Bvd$ $\varepsilon_0 = 8.85x10^{-12} \frac{C^2}{N-m^2}$

$q_e = 1.6x10^{-19} C$ $m_p = 1.67x10^{-27} kg.$ $m_e = 9.11x10^{-31} kg.$ $\mu_0 = 4\pi x10^{-7} Tm/A.$

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DEPARTAMENTO DE FISICA, USAC

$dq = \lambda\, dl$ $q = \sigma A$

$C = \frac{q}{\Delta V}$

Área	Volumen	Área
	$\frac{4}{3}\pi r^3$	$4\pi r^2$
	$\pi r^2 l$	[illegible]

Cilindro

Esfera

$W = -\Delta U$

$\Delta U = -qV$

$U = k\frac{q}{r} = k\frac{q_1 q_2}{r}$

$V = -\frac{\Delta U}{q}$

$V = E \cdot r$

$V = \frac{kq}{r}$

$s = r\theta$

$l = \pi r$

Esfera

$V = \frac{Q}{4\pi\varepsilon_0 r}$

$C = 4\pi\varepsilon_0 \frac{r_a r_b}{r_b - r_a}$